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NEUROBEHAVIORAL AND NEUROMETABOLIC (SPECT) CORRELATES OF PARANORMAL INFORMATION: INVOLVEMENT OF THE RIGHT HEMISPHERE AND ITS SENSITIVITY TO WEAK COMPLEX MAGNETIC FIELDS

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Experiments were designed to help elucidate the neurophysiological correlates for the experiences reported by Sean Harribance. For most of his life he has routinely experienced "flashes of images" of objects that were hidden and of accurate personal information concerning people with whom he was not familiar. The specificity of details for target pictures of people was correlated positively with the proportion of occipital alpha activity. Results from a complete neuropsychological assessment, Single Photon Emission Computed Tomography (SPECT), and screening electroencephalography suggested that his experiences were associated with increased activity within the parietal lobe and occipital regions of the right hemisphere. Sensed presences (subjectively localized to his left side) were evoked when weak, magnetic fields, whose temporal structure simulated long-term potentiation in the hippocampus, were applied over his right temporoparietal lobes. These results suggest that the phenomena attributed to paranormal or "extrasensory" processes are correlated quantitatively with morphological and functional anomalies involving the right parietotemporal cortices (or its thalamic inputs) and the hippocampal formation.

Keywords anomalous behaviors, brain, electroencephalography, magnetic field stimulation, neuropsychology, SPECT

The central assumption of behavioral neuroscience is that all experiences are derived from brain function. One of the remaining anomalies that has been considered by some as a challenge to neuroscience has been the reports of individuals who claim they experience information about past experiences of other unrelated people or of those who correctly identify hidden objects by mechanisms not known to date (Persinger, 1974). The report of these experiences, when they have been demonstrated to be veridical, have been labeled as receptive psi phenomena.

Although the preferred explanations for these phenomena have ranged from "extrasensory" perception that can never be measured directly to delusional behavior on the part of the experients, few researchers have examined the brain function of individuals who reliably display these behaviors. We have assumed that awareness of information extracted from the environment (Jahn & Dunne, 1987), by classical or as yet unidentified cerebral processes, must be transformed into representations within the receptive cortices of the two cerebral hemispheres (Broughton, 1976, 1977; Ehrenwald, 1984; Persinger, 1993). These representations are then experienced as perceptions, memories, or other complex cognitive phenomena.

We designed a neuropsychological study for the psychic Lalsing ("Sean") Harribance (Harribance & Neff, 1976) in order to examine this possibility under experimental conditions. He is considered one of the most reliable and accurate individuals to access information about others and objects through mechanisms not known to date. His accuracy, as judged by both clients and experimental results (Klein, 1972; Morris, 1972; Roll, 1966, 1972, 1975; Roll & Klein, 1972; Stanford, 1975; Stump et al., 1970), has been sufficient to maintain his income and foster the formation of foundations and institutes.

Three assumptions determined the design of our experiments. First, if physical changes occurred within the brain of the psychic during receptive psi, then changes in electroencephalographic activity (that primarily reflect activity within the cerebral cortices) and metabolic activity within the brain should be quantifiable during these periods. Second, there should also be a systematic relationship between the amount of the measurement, such as the proportion of alpha rhythms during an experience, and the accuracy of the experience. Third, if the brain processes associated with receptive psi are subtle, involved with the memory (consolidation) process (Roll, 1966), and sensitive to environmental changes, then the person who is prone to these experiences should also be very responsive to weak, complex magnetic fields whose temporal structure simulates brain activity and imitates the temporal patterns associated with long-term potentiation (LTP).

METHODS

Subject

Mr. Harribance visited Laurentian University's Neuroscience Research Group during May 1996 and June 1997. He was born on November 11, 1939, in Trinidad. When he was a young child he was burned by boiling water and remained in the hospital for about one month. Language development was delayed; as a result of this, he did not begin school until about 7 years of age. When he was about 13 years old, he fell from a tree and fractured his left leg and

left arm. After that period he recalls that his psi experiences occurred frequently.

Although he was reared within the Hindu tradition, he was attracted to Christianity. On several occasions he heard an inner voice that he attributed to Christ. Mr. Harribance indicated that he could not learn scholastic material directly; instead, after feeling or touching the texts, he says that he "knew" the information. During his career he has been tested numerous times for "psi ability." Most of the tests required him to identify objects or symbols that were hidden. His performance has remained remarkably above chance expectancy. One of the first electroencephalographic studies with this subject (Morris et al., 1972) occurred while he was guessing the sex of the person in photographs hidden in opaque envelopes: a positive correlation was found between the proportion of alpha activity over his occipital region and the proportion of correct choices.

Neuropsychological Assessment

Over a three-day period during 1996, the subject completed a thorough neuropsychological assessment. It involved the administration of approximately 100 norm-referenced and standardized tests (Persinger, 1995; 1999; Persinger & Richards, 1995) that we have routinely administered over the last 10 years to about 300 adult patients who had sustained brain trauma or cerebral damage. The tests included both traditional neuropsychological batteries, as well as those developed more recently to identify specific anomalies. The procedure also involved a neurological screening and tests for intelligence, memory, educational achievement, and personality. All raw scores were converted to z-scores. The profile was interpreted from a clinical context by the second author employing the same methods utilized for patients.

At the end of the first day of the three-day assessment, the subject sat in a comfortable chair within a darkened acoustic chamber. Silver-disc electrodes were attached to his scalp by EC2 electrode cream over the occipital (01,02), temporal (T3,T4), and frontal (F7,F8) lobes. Bipolar activity was recorded for about 30 min by a Grass P79 unit. Intrahemispheric comparisons between the occipito-temporal, temporofrontal, and fronto-occipital regions for each hemi-

sphere separate were also completed. We have found that this particular montage of EEG measurements, after a full day of cognitive challenge, often reveals subtle anomalies or distinctive signatures within brain activity.

During the subject's second trip to the laboratory (June 1997), some of the same tests were administered in order to discern test-retest reliability. Tests in which he had performed below average during the previous year, as well as a random selection of other tests, were employed. The correlation (r) between the standardized scores for the first and second administration was calculated.

Electroencephalographic Correlates With Receptive Psi Success

During the 1996 testing, the subject sat within the acoustic chamber while bipolar measurements of his EEG were completed over the occipital (01,02), temporal (T3,T4), and prefrontal (F7,F8) regions. He was asked to maintain eye closure while he felt the photographs of 10 different, single individuals supplied by a professor of biology who was not involved with the experiments. The rationale for the request to maintain eye closure was to increase the probability of the experience of "quick images" that are frequently associated with his reports.

The pictures were contained, facedown, within manilla envelopes. He proceeded ad libitum. With the exception of the request to maintain eye closure and minimize physical movement whenever possible, no other instructions were given to the subject. Key words and phrases were written directly upon the electroencephalographic record in order to later identify the relationship between his brain activity and the accuracy of his comments. All of the comments were also recorded on audio cassette and later transcribed.

The transcriptions were scored by the professor who supplied the photographs of the 10 members of her close family and who had exhibited at least one distinct medical diagnosis, such as diabetes. The professor was given the typed transcript for each person described by the subject and asked to rank the specificity of the statements for that person: –1 = not scorable, i.e., no comments at the time; 0 = not correct; 1 = mildly specific; 2 = moderately specific;

and 3 = very specific. This rater had never seen the EEG records and had not been present during the experiment.

A second experimenter who had not seen the rankings for specificity, hand-scored the EEG record for the approximately 40 min required for the task. Because only the occipital region displayed alpha rhythms, which are qualitatively easy to distinguish by their symmetrical morphology and frequency range (8–13 Hz), only this component of the record was measured. The temporal and prefrontal measurements had been clearly affected by artifacts from the temporalis and frontalis muscles (associated with talking) and were used as verifications of the time (to the nearest 2 s) associated with the comments written on the record.

The proportions of alpha rhythms over the occipital lobes within each of the 1,169 successive 2-s intervals that composed the session were scored by dividing each 2-s increment into 10 components. The proportion of the 10 increments that contained alpha rhythms was noted directly on the record. These values for each successive 2-s increment, as well as the rating of accuracy for the comments, were loaded for computer analysis.

To discern a possible relationship between the degree of accuracy for the comments and the proportion of alpha rhythms over the occipital area during the statements, one-way analyses of variance (ANOVA) were completed for the proportion of alpha rhythms as a function of the four ratings (incorrect to very specific). To verify that any significant relationship between the degree of accuracy and proportion of alpha rhythms was specific to the real time of the occurrence, lag/lead analyses were completed.

The 10th lag was calculated for the rating variables and was employed as the independent variable. Lags 1 through 21 were calculated for the proportion of alpha rhythms. As such, lag 10 for the alpha measure was the same real time as the rating for the statement while lag 5 for the alpha measure occurred 10 s after the centroid of the statement while a lag of 15 would be the alpha measurements 10 s before the centroid of the statement. All analyses involved SPSS software on a VAX computer. Because the measurements were completed on the same source of variance (the subject) and many of the statistical tests assumed independence between conditions, the p values were set at less than .001 for statistical significance.

SPECT (Single Photon Emission Computed Tomography)

During the 1997 visit, two Tc-99m SPECT ECD brain scans were completed in order to contrast a baseline resting condition with a psi task condition. For both conditions, the subject was injected with a tracer prior to SPECT examination. This allowed the tracer to be absorbed by the brain during the activities assigned to the two conditions. During the psi task, the subject gave a psychic reading of pictures for about 45 min to a woman whose daughter had been murdered by an unknown person about four years previously. During the resting condition the following day, the subject relaxed and meditated for the same period within the same setting. After each condition, he was transported to a local hospital laboratory for the SPECT brain scans. Each scan required about 45 min to complete. The computer images were interpreted by an expert who routinely evaluates these type of data within the medical population and for patients who have sustained brain injury.

Sensitivity to Application of Weak, Transcerebral Complex Magnetic Fields

During the second visit, the subject was asked to sit quietly in a comfortable chair that was housed within an acoustic chamber. The eyes were covered by a small mask. He was told that he could push a button if a presence was felt; he was instructed to press either the left or right hand button if a presence, like someone in the room, was felt on the left or right side, respectively. If the presence was along the back, both buttons were pushed. The occurrence of the button responses and verification of the field presentation from a sensor near the solenoids generating the fields were measured by continuous strip-chart recording.

The complex magnetic fields were applied bilaterally from two containers that were attached to each temporoparietal region of the scalp by velcro straps (Baker-Price & Persinger, 1996). The field strengths at the distances of the upper layer of the cortices was between 0.5 and 1.5 microT. The wave patterns were generated by a series of numbers between 0 and 255 that were transformed from digital to analogue values and amplified. He was exposed twice

without interruption to the following sequence of patterns: no pulse, 3.3 Hz sine-wave, no pulse, long-term potentiating pulse (LTP; Richards et. al., 1996), no pulse, 1.6 Hz sine wave, no pulse, and the burst-firing pattern (Richards et al., 1992).

The duration of the no pulse interval was 3 min, the field intervals were 2.5 min. The interstimulus presentation (time between envelopes) was 4 s and the duration of each point (the number between 0 and 255) that composed the sequence of numbers that generated the wave shape was either 1 ms or 3 ms. Real time disk-to-port latency for each pixel was 190 micro-s.

RESULTS

Neuropsychological Assessment

The results of the neurological screening examination did not indicate any qualitatively obvious signs or symptoms that would suggest clinical anomalies or pathologies. Mild suppressions of the left ear during bilateral aural stimulation and a mild right-sided neglect were equivocal. There was no evidence of either imperceptions or suppressions during tactile stimulation to the hands and face, or during visual stimulation of the upper, middle, and lower visual fields.

The standardized (z) scores for the various tests administered are shown in Table 1. The subject's scores for general level of intelligence, educational achievement, and general memory capacity were within the normal but below average range. However, his neurocognitive proficiency, the inverse of neuropsychological impairment, was 3 standard deviations below the mean. Both the standardized score and the discrepancy between his level of intelligence and neurocognitive proficiency indicated that he displayed a significant neuropsychological anomaly.

Although an anomaly is often perceived within clinical contexts as due to damage or dysfunction, we appreciated that a brain whose microstructure was different from other brains might also display abnormal scores. They would not necessarily indicate damage. However, to remain objective within a clinical context these terms were employed.

TABLE 1. Standardized scores for various neuropsychological and cognitive measures for Sean Harribance. The right hand, right foot, and left eye were dominant

Measure	*z-score*
Verbal Intelligence	–0.4
Performance Intelligence	–1.9
Wechsler's Memory Quotient	–1.1
Peabody Picture Vocabulary	–1.9
Reading	–1.2
Spelling	–1.3
Arithmetic	–0.9
Finger Tapping: right	–1.4
Finger Tapping: left	–0.2
Foot Tapping: right	–1.6
Foot Tapping: left	+0.1
Simple Reaction Time: Right Foot	–4.7
Simple Reaction Time: Left Foot	–1.4
Grip Strength: right	–2.1
Grip Strength: left	–2.5
Grooved Peg Board: right	–2.1
Grooved Peg Board: left	–2.5
Progressive Holes: right	+1.5
Progressive Holes: left	+0.5
Maze Coordination: right	–1.5
Maze Coordination: left	+1.2
Finger Gnosis	+1.0
Finger Gnosis Left/Right Differences	0.0
Finger Graphaesthesia	–0.5
Finger Graphaesthesia Left/Right Dif.	–1.0
Toe Gnosis	–0.4
Toe Gnosis Left Right/Differences	–0.8
Toe Graphaesthesia	–1.9
Toe Graphaesthesia Left/Right Dif.	–1.5
Tactual Performance Test (TPT)	
Right hand	–2.1
Left hand	–1.6
Both hands	+0.2
Total Time	–1.4
Memory	–1.2
Localization	–1.2
Rey-Ostereith Complex Figure Drawing	–4.0
Rey-Ostereith Complex Figure Recall	–6.3
Hooper Visual Organization Test	–2.5
Spatial Span	–0.3
Trails A	–0.9
Trails B	–2.4
Design Fluency	–1.7
Conditioned Spatial Association	–4.4
Category Test	–1.4

(Table continues on next page)

TABLE 1. Standardized scores for various neuropsychological and cognitive measures for Sean Harribance. The right hand, right foot, and left eye were dominant (*Continued*)

Measure	*z-score*
Stroop	
Word	+1.0
Color	−0.2
Color-Word	−1.0
Interference Score	−1.3
Seashore Rhythm Test	−0.7
Speech Sounds Perception Test	−3.1
Auditory Closure Test	−4.0
Dichotic Word Listening	
Left Ear	−1.0
Right Ear	−4.3
Both Ears	−2.8
Verbal Fluency	−0.3
Chicago (Written) Word Fluency	−0.4
Sentence Memory	−1.3
Rey–Auditory Verbal Learning	
Trial 1	−1.7
Trail 5	−0.9
Recall of List A	−2.3
Recall of List B	−2.5
Token Test (receptive)	−0.0
Token Test (expressive)	−2.3
Complex Partial Epileptic Signs	+0.1
Personal Philosophy Inventory	
Control Items	−2.3
Primary Temporal Lobe Signs	+0.4
Complex Partial Signs	+1.2
Myers–Briggs Type Indicator	ISTJ

The results of the gradient analysis, by which all of the standardized scores for the performance-based tasks were ranked from most to least impaired, indicated that the subject displayed: 1) mild hypofunction within the left prefrontal region, 2) moderate dysfunction or structural reorganization within the left superior temporal gyrus, and 3) moderate dysfunction or structural anomalies within the right occipitoparietal region. Support for the presence of a mild hypofunction within the left prefrontal region included the subject's mild deficits for: 1) right finger agility, 2) right foot agility, 3) right toe graphaesthesia, 4) right finger graphaesthesia, and 5) visuomotor coordination for the right hand despite normal scores for these capacities for the left (nondominant) hand.

There was also no evidence of complex partial epileptic-like signs or excessive anxiety that could have confounded or masked the results. Subtest analysis indicated that the subject did not display the classical profile of complex partial epileptic-like patients. The only significant elevation occurred for clusters of items by which a sense of presence, widened affect, and visual sensations are inferred (Persinger & Makarec, 1993).

Personality

According to the results of a norm-referenced inventory whose items were derived from normal concepts of behavior, the subject displayed elevated scores for factors from which psychologists infer humility, tender-mindedness, shyness, and conservative approaches. Men with this profile are more emotionally cautious, threat-sensitive, inhibited, and conscientious than the average person.

Men with this subject's profile are usually more dependent, overprotected individuals compared to the average person. However, these men also display a balance between the propensity to be impatient, introspective, and attention seeking, with a proclivity to be gentle and indulgent to themselves and others. A standardized profile for psychometric scales derived from psychiatric concepts of behavior (the Minnesota Multiphasic Personality Inventory) indicated that all scales were within the normal or expected range for his age.

Screening EEG

Bipolar activity over the prefrontal, temporal, and occipital lobes was dominated by beta frequency rostrally and by a near-continuous train of alpha rhythms over the posterior regions. Because the subject was frequently vocalizing, the temporal and frontal regions were dominated by fast beta activity. There was no evidence of classical epileptiform signatures. Heart rate ranged between 78 and 81 bpm with no evidence of aperiodicity.

Interhemispheric comparisons between the left and right temporofrontal regions were coherent and dominated by fast beta activity. However, occipitotemporal comparisons were anomalous. The

left hemisphere displayed more frequent episodes of slow alpha rhythms compared to the right hemisphere. Subsequent analysis indicated less symmetrical patterns over the right hemisphere. A higher frequency component (>30 Hz) was superimposed upon the fundamental (alpha) pattern. This component occurred with bursts of approximately 100 to 400 ms and although intermittent was quite frequent. The discrepancy was conspicuous and suggested a marked elevation of activity over the right caudal hemisphere. Fronto-occipital comparisons showed relatively coherent trains of alpha rhythms interhemispherically.

Test-Retest Results

The results of the second administration of selected tests that were administered during 1997 are shown in Table 2. The correlation (r) between the first and second tests, separated by one year, was .89. The means and standard deviations for 18 measures for the first administration and the second administration were –2.85 (1.85) and –2.76 (1.56), respectively. There was no significant difference [$t(15) = .45$, $p > .05$] between the means.

TABLE 2. Standardized scores for specific tests administered during 1996 and 1997

Test	*1996*	*1997*
Toe gnosis	–0.4	–1.6
Toe gnosis (left/right differences)	–0.8	–2.1
Toe graphaesthesia	–1.9	–1.4
Toe graphaesthesia (left/right)	–1.5	–2.7
Tactual Performance Test (right)	–2.1	–2.1
Tactual Performance Test (left)	–1.6	–1.6
Rey-Ostereith (Copy)	–4.0	–2.5
Rey-Ostereith (Memory + 30 min)	–6.3	–7.0
Hooper Visual Organization Test	–2.5	–2.5
Trails A	–0.9	–0.9
Trails B	–2.4	–2.4
Speech Sounds Perception Test	–3.1	–2.0
Auditory Closure	–4.0	–3.3
Dichotic Word Listening Left Ear	–1.3	–1.2
Dichotic Word Listening Right Ear	–4.3	–4.3
Dichotic Word Listening Both Ears	–2.8	–2.7
Conditioned Spatial Association		
Correct Blocks	–4.4	–4.0
Errors	–7.0	–5.4

Electroencephalographic Correlates With Accuracy for Personal Pictures

The proportion of time per 2-s increment for the presence of alpha rhythms during the 38.9 min (1,169 segments of 2-s scoring) of measurement is shown in Table 3. The mean and the standard deviation for the proportion of alpha rhythms within the segments was 12.1 and 17.0, respectively. The numbers of 2-s periods that were associated with statements were: not scored, 499; not correct, 121; mildly specific, 35; moderately specific, 85; and very specific, 429.

The proportion of the 2-s period that displayed alpha rhythms for the 10, 2-s increments (20 s) before (–) the approximate time of the comments by the subject, the same time as the comments (0) and for the 10, 2-s increments (20 s) after (+) the comments are shown in Figure 1 for statements that were judged independently to be not correct (false), mildly specific, moderately specific, or very specific. One-way analyses of variance (ANOVA) indicated that the most significant differences in the proportion of alpha rhythms occurred within the few seconds around the time of the impressions reported by the subject. Those statements that were judged to be mildly specific, moderately specific, or very specific were associated with more alpha activity (about 14%) over the occipital regions relative to those statements that were judged as not correct (about 7%).

TABLE 3. Numbers of 2-s increments during the receptive psi task that contained various percentages of alpha rhythms over the occipital lobes

Percentage of alpha	*Number of 2-s increments*
0	651
10	94
20	226
30	61
40	74
50	22
60	29
70	5
80	3
90	4
100	0

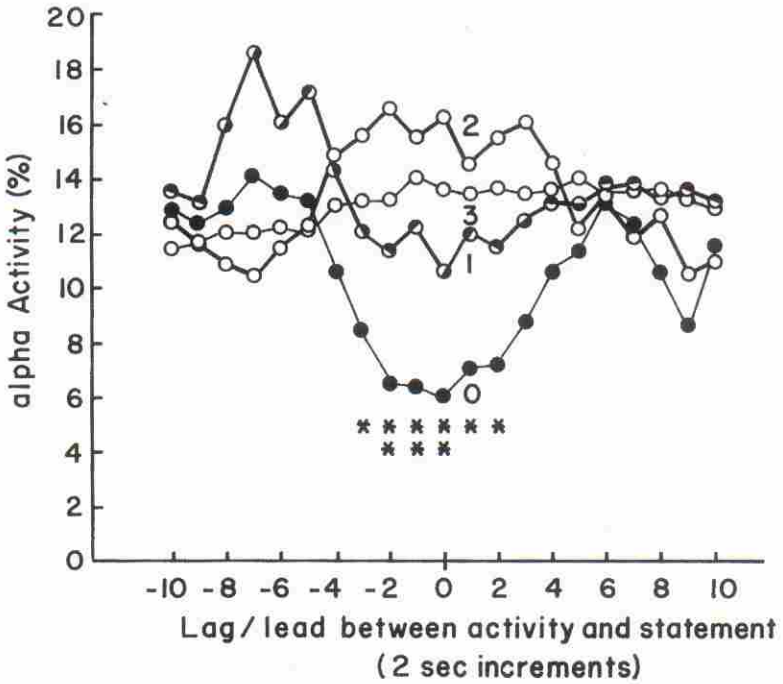

FIGURE 1. Proportions of alpha activity per 2-s increment over the occipital lobes during the time of (lag 0), successive 2-s increments before (– integers), or successive 2-s increments after (+ integers) of the statements for pictures. The ratings of the statements were 0: erroneous; 1: mild specificity; 2: moderate specificity; and 3: very specific. "

The greatest relative increase in the proportion of alpha rhythms occurred for the impressions that were judged to be moderately correct. The impressions that were judged to be incorrect with respect to the person in the photograph were associated with the lowest amount of alpha activity. However as noted in Figure 1, the proportion of alpha activity was higher during the period 10 s before the inaccurate impressions. A similar pattern was noted for those impressions judged as mildly specific.

To reduce the possibility that these results were due to an intrinsic periodicity in the rated accuracy of his statements, autocorrelations were completed between the proportion of alpha rhythms per 2-s increment and for each of the 2-s lags for a total of 30 lags

(60 s). Both nonparametric (rho) and parametric (Pearson *r*) correlations indicated no significant periodicity within this range. The strength of the coefficients decreased from .25 to less than .10 when the autocorrelations exceeded more than six lags.

SPECT

The most striking correlate occurred when the subject was engaged in what he described as receptive psi (compared to the baseline rest condition). There was a relative hyperperfusion of tracer within the region of the paracentral lobule of the right parietal lobe. The hyperperfusion extended dorsally and laterally into the superior parietal lobule. The conspicuous anomaly was not present during the resting (baseline) state. A secondary, very focal anomaly, when he was engaging in receptive psi, occurred within area 44 adjacent to the Sylvian Fissure in the right hemisphere.

When referenced to the uptake within the cerebellum, there was hypoperfusion of tracer within both anterior temporal lobes during both the baseline and active (psi) state; the decrease was greater in the left hemisphere than in the right hemisphere. Mild attenuation of uptake of tracers was also discriminable within the left thalamus and left basal ganglia. A more prominent reduced perfusion was discernable in the thalamic midline. Some focal decreased uptake within the infero-orbital frontal poles was observed. The left side was more affected than the right.

Complex Electromagnetic Field Stimulation

The subject's responses to the application of transcerebral magnetic fields were conspicuous. The average numbers of button presses per min (rounded to the nearest whole number) during the 3.3 Hz, LTP, 1.6 Hz, and burst-firing pattern were 12, 22, 8, and 7, respectively. The responses during the no-field conditions ranged between 5 (first interval) and 10 (last interval) presses per min. For the same paradigm, the average person in our studies has displayed between 0 and 3 button presses per pattern.

Chi-squared analysis [$\chi^2(6) = 34.81$, $p < .01$)] indicated a significant disconcordance from chance (averaged) expectancy, which was

due primarily to the enhanced experiences during the presentations of the LTP pattern. Whereas the ratios of left-to-right references for the sensed presence were about 1.5:1 for the sham field, 1.6 Hz (sine wave), and burst firing pattern, and about 2:1 for the 3.3 Hz pattern, the ratio shifted to about 6:1 during exposures to the LTP patterned field. The subject identified the presences as the religious figures Christ and Mary.

DISCUSSION

The results of these experiments with Sean Harribance are consistent with the general patterns of observations reported in the scientific literature concerning receptive psi. An important role of the right hemisphere in the production of receptive psi was considered during the late nineteenth century (Harrington, 1995). Even from a nontechnical perspective, the experiences and behaviors associated with people who consistently display phenomena, regardless of their validity, labeled as "clairvoyance" or "telepathy" are similar to those of people for whom anomalies within the right temporal or right parietal lobes have been documented.

More than 25 years ago, Morris et al. (1972) reported a positive association between the accuracy of psi responses by this subject for target stimuli and the occurrence of alpha activity. In the present study, the subject's specificity of details about the individuals within photographs that he held but did not see was significantly correlated with the proportion of alpha rhythms between his occipital lobes at the time of the statement.

This quantitative relationship between the judged specificity of the statements for each of 10 pictures of people and the proportion of alpha activity at the time of the statement would be consistent with less processing of visual information within the occipital region. In normal brains increased durations of alpha rhythms are associated with greater incidence of visual imagery and free-associative thinking than during more active periods. However, increased proportions of alpha frequency, although they may reflect a shift of the responsiveness from external to internal stimuli, do not indicate the veridicality of the experiences.

When the subject was measured during 1996, he displayed slower alpha rhythms over the left occipitotemporal region compared to the right occipitotemporal region. This discrepancy was due to the occurrence of faster frequency activity that was superimposed upon these alpha rhythms over the right hemisphere. Within the limits of resolution for strip chart recordings, these multiple bursts of fast frequency, whose durations were between 100 msec and 400 msec, would have been 30 Hz or greater. The results suggested that the right hemisphere exhibited an unusual but not necessarily abnormal pattern of activity.

The subject's neuropsychological profile revealed three clusters of psychometric anomalies that are generally associated with hypofunction within: 1) the left prefrontal region, 2) the left superior temporal gyrus, and 3) the right parieto-occipital region. The first two anomalies were reflected in the SPECT measures for both baseline and psi conditions, while the third anomaly occurred only during his psi experiences. The demonstration that these deficits were not secondary to a mild motor anomaly was indicated by the similarity of the magnitude of the deficit for tasks that required sensory and stereognostic discrimination.

In light of his average scores for fine bilateral motor control, confounding effects from general motor weakness were not likely to have produced the left prefrontal deficits. His impaired ability to rapidly alternate between conceptual sets, despite a normal capacity to engage in sequential activity, would be considered a strong indication of left prefrontal anomalies. These performance-based impairments were supported by the hypoperfusion of tracer within the left infero-orbital pole compared to the right homologous regions, as discerned by the SPECT.

The second cerebral area that is very likely to display a structural anomaly, rather than hypofunction, involved the left superior temporal gyrus. This conclusion is derived from the hypoperfusion of tracer within the left temporal lobe, according to the SPECT data for both conditions and the subject's moderate deficits for a task that required association of phonemes with their printed equivalents. The specific deficit for the detection of words for the right ear during a dichotic listening task was also consistent with an anomaly within the left superior temporal gyrus. Although this deficit may

have been present since childhood and could have contributed to his scholastic difficulties with the acquisition of language, the severity of the deficit was too extreme to have been present at this magnitude since childhood because his present standardized reading/decoding scores were within the normal, albeit below average, range.

The third cerebral area that is very likely to display a structural anomaly rather than hypofunction involves the right parieto-occipital region. Microstructural differences in this region would be sufficient to affect the subject's perception of visual gestalts. This patient displayed moderate deficits for: 1) a visual organization test (no copying required) and 2) the copy of a complex visuospatial pattern. A deficit of this magnitude is unusual, except in situations of known pathology (e.g., focal stroke) for which there was no available medical evidence for this patient. However, a deficit for visuospatial organization of this level would be sufficient to generate the deficits for visuospatial reasoning and conditioned spatial association.

Evidence that the deficits were within the cortical regions of the right occipitoparietal region, rather than within subcortical (right hippocampal) regions, was suggested by his average score of spatial span and the absence of discrepancy in the standardized scores between spatial span and digit span. Although a mild anomaly of the right lateral or orbitofrontal region might be present (which could also be associated with the weaknesses for spatial orientation), this hypothesis would be weak. The patient's age-appropriate and normal score for the discrimination of tonal patterns minimized the possibility that these deficits were secondary to generalized difficulties within the right temporal lobe. This neuropsychological profile was stable, as indicated by the very strong correlation between the standardized scores for the performance-based tests, even though the test-retest interval was one year.

The results of the neuropsychological assessment and the screening EEG strongly indicated that an anomaly existed within the right parieto-occipital region and that this area was likely involved with the process the subject attributes to receptive psi. This area, specifically along the medial surface of the right hemisphere within the paracentral lobule, was activated very conspicuously according to the SPECT measurement during his response to held photographs compared to baseline resting conditions. Very generally, the func-

tions of this region involve the creation of the affective associations with the neuroelectrical representations of patterns of stimuli when they are organized by the cerebral cortices into meaningful perceptual experiences.

PET (Positron Emission Tomography) studies, employing normal right-handed subjects, have shown the medial portion of the parietal cortices, the precuneus, displays increased activity during retrieval. One proposal is that this activity reflects the use of visual imagery as a mnemonic (Fletcher et al., 1997). Because there may be a dissociation between medial parietal activity that is sensitive to imagery and to those regions typically activated during episodic memory, the imagery might be accessed by processes (Posner & Rothbart, 1991) other than the memories subject to the "awareness" of the person.

Results from tests of autonomic psi (Braud et al., 1993; Dean, 1966) suggest that objects in the distal environment can affect the organism without necessarily the organism's awareness. "Awareness" in the human being arises at the level of re-entrant processes and third or fourth order emergent phenomena that occurs after the filtering, enhancement, and synthesis of massive numbers of impulses from sensory arrays throughout the body (Edelman, 1989). Very little of this information in its raw form "enters" awareness and hence becomes subject to the declarative memory accessed by linguistic processes that include the understanding, utilization, and expression of language.

Although increased metabolic activity within neurons of the right parietal lobe, as indicated by SPECT, and the increase in alpha activity, as inferred by electrical measurements, indicate a neuronal correlate for the subject's receptive psi, these measures are too nonspecific to discern mechanism. Increased perfusion of tracer may suggest more activity, but it does not allow the specific discrimination of which neurons are activated and does not reveal in which pattern they were activated. The time frames required by SPECT to discern changes in the density of perfusion and inferred metabolic activity within brain space are hundreds of times longer than those associated with specific neuronal patterns that define the increments of experiences.

Consequently, we applied complex magnetic fields whose

temporal structures overlap, in real time, with the same neuroelectrical processes that generate normal experiences. We know these fields evoke a sensed presence or sentient being, particularly when the fields were applied across the temporoparietal regions of the left and right hemisphere (Persinger, 1999, 2000). For the average person, applications of these weak complex magnetic fields with the strongest field strengths over the right hemisphere have generated presences experienced as behind or to the left of the person. For some individuals, attempts to "focus" upon the sentient entity or presence is associated with the experience of its movement within their local space.

We have interpreted this experimental elicitation of the sensed presence as support for the hypothesis that these experiences are the transient perceptions of the right hemispheric equivalent of the left hemispheric sense of self (Johnson & Persinger, 1994; Persinger, 1993). Usually the awareness of this representation of the self within the right hemisphere is inhibited by the more dominant left hemispheric processes. During conditions that allow intrusions of more active right hemispheric activity, such as during some dreams or when the right hemisphere is asymmetrically activated, the probability of experiencing the presence increases.

Because the composition of the neural patterns that contain the sensed presence would be expected to reflect the functional properties of the right hemisphere, the concomitant experiences should be organized according to the dimensions of affect or meaning and are often emotionally negative. However, brief intercalation in the order of 20 ms to 200 ms (Cook, et al., 1999) between the right and left hemisphere might also allow the inclusion into awareness of information detected and processed by the right hemisphere that would typically not access normal awareness (Dixon, 1979; Radin, 1996). One of the most striking examples of this capacity for the normal human brain is the "hidden observer." Following a hypnotic instruction, the person can solve an "unsolvable" complex problem whose solution was given during right hemispheric dominance, even though the person does not remember the instruction or the situation in which the information was acquired (Hilgard, 1984; Kunzendorf & Boisvert, 1996).

The results of this study indicated that sensed presences could be

evoked by specific patterns that are frequently associated with producing long-term potentiation in slices of hippocampal tissue, as well as altering the contextual dimensions of memory specific to the hippocampus (McKay et al., 2000). In the present experiment, this pulse was presented once every 4 s by four sets of solenoids whose activation also produced a superimposed 0.5 Hz rotating magnetic field. The application of this specific pattern across the temporoparietal lobes resulted in experiences that were localized primarily by the subject to his left side.

The specificity of the response to the long-term potentiating pulse was indicated by the numbers of references to sensed presences compared to numbers of experiences during the presentation of a 3.3 Hz sine-wave, 1.6 Hz sine-wave, a burst-firing pattern derived from the epileptic discharges of amygdaloid neurons, or the no field (sham) condition. Because the 3.3 Hz, 1.6 Hz, and burst-firing pattern were also presented once every 4 s, we concluded that it was the specific pulse pattern, characterized by a single pulse, followed 170 ms later by four rapid pulses (the LTP pattern) that resulted in the enhanced experience of a presence.

Such lateralization might indicate that the subject's right temporoparietal region was more sensitive to these complex fields. When this particular pattern was applied, aggregates of neurons involved with his body image, sense of self, and spatial location could have been activated and he experienced a presence. That these experiences could be evoked after only 20 to 30 s of application of field strengths around 1 microTesla (10 mG) near the surface and an estimated 10 to 100 nanoTesla (or less) within the cerebral cortices themselves also suggests a sensitivity of his brain. Altered arrangements of only a small number of neurons within his brain might allow for the detection of responses to stimuli that could not be represented within the compatible circuitry of the normal brain.

The experience of the sensed presences along his left side, that he perceived or labeled as Christ and Mary, and whose images often accompany his receptive psi, could have involved activation of the right parietotemporal regions and the intrusion of these representations into awareness. This experimental elicitation of the experience could be considered strong evidence that the right hippocampus or its afferent structures, such as the parahippocampal gyrus,

directly activated the right parietal cortices. The delay between the application of the fields and the production of button presses indicating a sensed presence was within the range of about 20 or 30 s. Such latencies would support a circumlocutious route from the hippocampus into the brain stem or thalamus before entering the cerebral cortices and hence awareness (Lieb et al., 1987).

Activation of the right caudal hemisphere during receptive psi would be congruent with the subject's report that he frequently perceives images or impressions within the peripheral extent of the upper left visual field during receptive psi. In the normal brain (Corbetta et al., 1991), such activation in the upper left quadrant of the peripheral field would be typical of electrical transients within the *right* temporo-occipital lobes. According to classical neurological interpretations, transients within the lower peripheral quadrant of the left visual field would imply parieto-occipital involvement. The focal, enhanced perfusion of tracer within area 44 of the right hemisphere when he was engaged in receptive psi would be consistent, but not exclusive, support for involvement of temporo-occipital pathways within the right hemisphere.

The essential neurochemical processes and complex of neuroelectromagnetic patterns that are most correlated with his receptive psi experiences cannot be discerned from our results because the measurements did not have the appropriate spatial and temporal resolutions. However, if the enhanced perfusion of tracer within the more medial and dorsal portions of the right parietal lobe reflected more neuronal activity (rather than enhanced activity of glial cells or pericapillary systems), then the concomitant occurrence of enhanced alpha rhythms would suggest increased inhibition by interneurons during receptive psi.

Enhancement of alpha rhythms or the increased power of alpha activity within the cortices is usually associated with a decrease in the sensory processing of external stimuli. The temporal structure of the cortical activity during these periods of minimal afferent information is often maintained by input from nuclei within the thalamus or, potentially, from the hippocampal regions through midline thalamic groups. If the concurrence of both increased metabolic activity and alpha power occurs consistently when the subject engages in receptive psi, then direct information from the right

hippocampal region or through its thalamic connections cannot be excluded.

The responsiveness of the subject's subjective experiences that were dominated by the sensed presence to a weak magnetic field whose temporal parameters encourage long-term potentiation, suggests a central role of the hippocampal-entorhinal connections and the parahippocampal gyrus in phenomena that have been traditionally labeled as receptive psi. Activation of the entorhinal-hippocampal system depends upon patterns of electromagnetic signals with specific space-time configurations. This pattern of intrinsic activation recruits neuronal aggregates within the cerebral cortices that represent previously consolidated information, that is, memories.

Roll (1966) has emphasized that the receptive psi response incorporates memory images. From his perspective, the temporal lobes and the entire multimodal complex within their space serves not only as the biological substrate to memory consolidation, but also as "receptor" for information acquired through nonclassical sensory input. While the hippocampus provides the cognitive map for the organism within three dimensional space and perhaps even space-time, the amygdala alerts the organism to the emotionally important coordinates of stimuli within space (that we perceive as three-dimensional objects over time) and ascribes meaning to those objects.

One hypothesis that would integrate the results of the present study with the subject's experiences and his specific form of experiencing accurate information about nearby objects or people would involve the following: Because the subject did not show evidence of the subjective experiences, electrical lability, or elevated electrical anomalies that typically define complex partial seizures (Persinger & Makarec, 1993), his sensitivity to the weak complex magnetic fields to which normal hippocampal tissue respond would be due to permanent neuronal properties. In essence, they would be subject to the same modulating factors, such as fatigue or altered arousal during distracting settings, as these structures within any other human brain.

An ontogenic alteration of microstructure (defined by the structure of synapses and the correlated electrical patterns) within the subject's right parieto-occipital region due to early injuries may have resulted in his ability to discern information that is contained within

the space of photographs. This information is not discernable by normal vision, but might be contained within the visual image of the person or setting at the time of the photograph. Effectively, the stimuli he perceives would be a fusion of visual and haptic elements, a kind of synaesthesia. During these periods this region of the brain is dominated by alpha activity which indicates the neurons are not receiving active input from visual, tactile, and proprioceptive modalities.

Within the ventral portions of the temporal lobes, information from the environment that is typically not detected by the normal brain or is filtered by the normal brain, is integrated with or converges with visual-tactile inputs from the parieto-occipital regions. Because the parahippocampal gyrus is structured to integrate multimodal sensory information into a common neural code (a type of common language), so that information from throughout the brain can be integrated, this "other information" within the environment would be required to access this neural code or to be functionally presented *within* the brain as this code.

John (1990) has repeatedly emphasized the importance of fundamental algorithms within electrical patterns from which information is generated and experienced. All sensory inputs are translated to these forms. Normally this information is obtained through the transduction of physical energies within the traditional sense organs into this code. There are many energies, prevalent within and through space and time, to which the normal human brain does not respond if they are presented in noncongruent forms, even when they move through the brain.

Extremely low frequency magnetic fields from applied sources are one of the few forces that can penetrate the skull and occupy space within brain tissue. There has been substantial empirical evidence to support a powerful role of complex, very low intensity magnetic fields that could carry information. PicoTesla, pulsed, extremely low frequency magnetic fields have been associated with marked improvements in individuals who display right hemispheric dysfunction (Sandyk, 1993, 1994, 1995). If such very weak fields can affect larger chemical aggregates than small molecules, such as serotonin or melatonin, then the existence of very complex weak magnetic fields within the environment, hereto not measured by

traditional magnetometers (whose limits are in the order of 0.1 nanoTesla), might be a source for this other information described by Jahn (1996).

The combination of very *high complexity* but very, very low intensity of these magnetic fields might be sufficient to contain millions of bytes of information per cubic meter. One suggestion for the source of this "other information" would involve a combination of gravity waves and electromagnetic patterns as predicted by Jacobson's model of resonance (Jacobson, 1994; Jacobson et al., 2000). According to his theory and equations, very weak magnetic fields, within the range of a picoTesla, can affect the brain through resonance interactions. These strengths are about one million times smaller than the ones generated by our equipment and about one thousand times smaller than the likely magnitudes of these fields when they extend into the brain, although picoTesla intensities would be present as eddy patterns and higher order derivatives.

We hypothesize that the subject's experiences are a series of fragments of images and ideas that would be the correlate of the recursive processes between the parieto-occipital region and the parahippocampal region. These psi experiences would be constantly integrated with normal sensory input. During times when the latter predominate, his accuracy would be less and subject to the same influences as those of the average person. His specificity for individuals would also be reduced or influenced simply by experience and extrapolation. Consequently, the positive association between alpha activity over the parieto-occipital regions and the specificity of his receptive psi or its accuracy would simply reflect the greater exclusion of normal sensory processing.

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